E/CONF.39/D/1
21 Sept. 1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item : D.4

United Kingdom

ANTIBIOTICS IN THE PRESERVATION OF FRESH MEAT AND POULTRY

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Agenda Item D.4.

ANTIBIOTICS IN THE PRESERVATION OF FRESH MEAT AND POULTRY

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1. Throughout the ages, man has devised various methods for prolonging the storage life of perishable foods and, whilst many of these methods have since been rejected, others are still in use. The majority were based upon drying, salting, canning, cooking, fermenting or freezing. As a result of extensive research, observation, and practical experience, most foods can today be preserved for an indefinite period without affecting either their quality or palatability. The problem of preserving meat, poultry and fish, however, has not been entirely solved. Good though the modern methods are, they not only affect to a certain extent flavour and colour, but also generally demand expensive installations and maintenance. It has, therefore, not been surprising that the food producer should turn his attention towards antibiotics, once their potent bacteriostatic and bactericidal properties have been proved in human medicine. The lead in this search for a new and more practical preservative was taken by the United States where, in 1955, an antibiotic for the conservation of fresh poultry was introduced into the Food and Drugs Act.

2. Although this idea has steadily gained ground all over the world, little use is being made of these new drugs as a preservative for staple foods. It is feared, rightly or wrongly, for instance, that treated meat eaten in quantity may have ill effects upon health or that unscrupulous butchers may try to cover insanitary or unhygienic practices as they have done many times in the past with other preservatives. Whatever the reason, the fact remains that the absence of proper methods of preservation, in underdeveloped countries in particular, not only affects national economy but constitutes a threat to health. In lands where cold storage facilities are few, a method should be found to prolong the keeping quality of perishable foods, in particular meat, poultry and fish.

3. To study the effectiveness of antibiotics we decided to give a trial to Oxytetracycline and Potassium sorbate, known commercially as Biostat and Sorbistat-K, and Chloratetracycline - Acronize in the preservation of fresh red meat and poultry. The experimental slaughter stock was composed of animals of average quality and consisted of 28 cattle, 24 sheep, 10 goats and 24 chickens. These animals were slaughtered in three groups; in the Athi River and Mombasa meat works of the Kenya Meat Commission, in a very simple local African abattoir and in typical primitive conditions under the shade of a thorn tree on the bare soil such as practised in the native reserve. The most unfavourable season for the keeping of any fresh foods was chosen for these experiments, namely the onset of the long rains. The carcasses were exposed to the temperatures of two different altitudes; the heat at sea level registering 90°F in the shade with a relative humidity of 100%, and the colder and drier climate of the 7,000 feet highlands. The post-mortem handling and treatment of the meat also varied considerably. While some of the quarters were moved immediately after slaughter, others were allowed to remain and lose their body heat in the hanging hall of the meat works. While a number were transported in a hanging position in clean and properly insulated meat vans, others were carried in the back of a station wagon or even in an open push cart used by the native butcher. The final destinations were as diverse as the means of transport. Some quarters were taken to a first-class European butcher shop, others were placed almost one on top of the other in an unhygienic African butcher, while others were exposed during 12 hours to the heat, dust and fly contamination of a native market stall in Mombasa. All experimental carcasses were held for 72 hours in the case of treatment with Biostat, 96 hours with Sorbistat-K and 96 hours when Acronize was used. The experimental animals were divided into groups and the antibiotic was applied either ante-mortem while the stock was resting in lairage or post-mortem after bleeding and dressing had been completed.

4. Five methods of applying the antibiotics were chosen and consisted of intravenous, intramuscular and intraperitoneal injections given four hours prior to slaughter, or an antibiotic spray applied immediately after the carcass was fully dressed and trimmed and finally by dipping in an antibiotic solution; this also after the carcass was completely prepared to leave the abattoir.

5. Biostat, injected intraperitoneally two hours prior to slaughter extends the keeping quality of fresh beef from 24 to 72 hours. Its use in slaughterhouses, however, cannot be

recommended as the immobilisation and injecting of each beast is a lengthy procedure upsetting the routine of even a small abattoir. Any method of preservation with an acceptable antibiotic must be simple and quick enough in application to fit into any routine abattoir procedure.

6. The spray with Biostat successfully replaces the intraperitoneal injection and is a method which can be fitted into the production line of any abattoir without any difficulty.

7. Acronize tends to taint the carcass if applied as a spray. Intravenously it is able to extend the keeping quality, but for reasons explained above this method is unsuitable.

8. Sorbistat-K applied as a spray undoubtedly gives the most promising results. Not only does it extend the keeping quality for up to 72 hours but it preserves the good appearance of the carcass and surpresses the growth of moulds so troublesome in hot and humid climates. Being readily dissolved in water it presents no difficulty when used in abattoir routine.

9. Although in their present form none of the drugs can replace cold storage, they can extend the keeping quality of beef for the desired 48 hours after slaughter. This critical period is of great importance to the butcher in tropical and subtropical countries who is not interested in preserving the meat for any longer period than the time required to sell off the carcass should he fail to attract sufficient customers in the normal 12 hours.

10. The preservation of small stock carcasses was disappointing. Even Sorbistat-K was unable to extend the keeping quality of sheep carcasses beyond 34 hours. Admittedly the animals used in the trials were of low quality but they represented the normal stock of the native areas.

11. The trials have made it quite clear that an antibiotic can neither be used to mask the poor state of the carcass nor can it improve its natural condition.

12. The preservation of poultry by the standard dipping method but without the addition of ice, proved to be a complete failure. (Trials with Sorbistat-K were not carried out). Not until the strength of the dipping solution was doubled or even trebled could the "shelf life" of the treated carcasses be prolonged by 48 hours. The treated carcasses then developed a different "off" odour from the control but the flesh remained

firm and did not become slimy as in the latter. The odour was not so pronounced as in the control and was more difficult to identify.

13. For the purpose of bacteriological examination surface cuts and deep tissue samples as well as swabs were taken. The contaminating organisms were mainly non lactose fermenting gram-negative rods and micrococci, whilst streptococci, usually faecalis but sometimes lactis or Type D, formed a variable proportion of the spoilage organisms. Lactobacilli and yeasts were not generally prominent although a heavy surface growth of an imperfect yeast of the genus Trichosporon occured on the sheep carcasses kept in Mombasa and not sprayed with Sorbistat-K. Of the gram-negative rods the frequent dominance on the sheep and also some beef (Mombasa) carcasses of Proteus spp., a genus with a high natural drug tolerance, may give cause for concern in carcasses treated with Biostat. The carcasses resisted clostridial spoilage while the control became infected with these organisms and coagulase positive staphylococci were suppressed.

14. The appearance of the treated carcasses, particularly those sprayed with Sorbistat-K, was good, but claims that an antibiotic has a tenderising effect could not be substantiated.

15. Heavy bacterial contamination interfered with the assay for residual oxytetracycline. In two tests, however, bacterial development was negligible, and these provide valid data of oxytetracycline persistence at low and high temperatures. The intraperitoneal injection of 15 grammes Biostat per 1,000 lb. liveweight gives a persisting residue of just over a microgramme per gramme of muscle tissue for at least three days. Using the spray method, however, antibiotic was not detected after the first day.

16. The accumulated assay of all treated meat samples with chloratetracycline showed either negative results or negligible amounts of antibiotic residue.

17. The whole subject of antibiotics has led to heated controversy. As antibiotics vary considerably in their chemical structure, in their toxicity and their selective action on bacteria, and as some organisms are able to develop a resistance to them, this particular disadvantage is a cause of concern to the public health worker. The fear is expressed that, were antibiotics used as food preservatives, bacterial resistance might be induced. The positive opinion, on the other hand, suggests that the use of antibiotics in the preservation of fresh meat, poultry and fish does not constitute a hazard to public health. But even if it could definitely be proved that no danger exists from the addition of well-established

quantities of antibiotics, methods governing their use must be laid down by law as the indiscriminate application of any preservative is a practice to be avoided. Preservation, it should be clearly understood, was never intended to replace hygiene nor to cover up developing spoilage, but to prolong the freshness of foods under commercial conditions and afford protection when unforseen delay occurs during normal distribution.

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E/CONF.39/D/1
SUMMARY
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ORIGINAL : ENGLISH

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SUMMARY

Agenda Item : D.4.

United Kingdom

ANTIBIOTICS IN THE PRESERVATION OF FRESH MEAT AND POULTRY

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ANTIBIOTICS IN THE PRESERVATION OF FRESH MEAT AND POULTRY

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SUMMARY

1. If a preservative, other than cold storage, could prolong the keeping quality of meat, much waste would be prevented, the standard of meat hygiene would be improved and less difficulty experienced in moving livestock from growing into urbanised consuming areas. The effect of such a preservative would also fully meet the demands of consumers in most countries in Africa and Asia who generally refuse to eat chilled or frozen meat.

2. To extend the storage life of fresh beef, mutton and poultry, Biostat, Acronize and Sorbistat-K were used both ante and post-mortem as intramuscular, intravenous and intraperitoneal injections or in the form of a carcass spray or dip.

3. All three drugs improve the keeping quality of fresh beef from 24 to 72 hours. Because of its tendency to leave a yellow stain on the carcass Acronize cannot be used as a preservative. Biostat, as a spray, inhibits superficial and deep spoilage. Particularly encouraging, however, is the action of Sorbistat-K as it does not only prolong the keeping quality of beef but maintains the good appearance of the carcass for as long as the meat remains fit for human consumption. As a spray it is easily applicable in any abattoir and its use is economical.

4. The keeping quality of sheep carcasses is not prolonged by either of the drugs.

5. The shelf-life of poultry was not extended by dipping carcasses in a solution of Biostat or Acronize without the addition of ice.

6. The accumulated assay of all treated meat samples shows either negative results or negligible amounts of antibiotic residue.

7. Although in their present form none of the drugs can replace cold storage, Biostat and particularly Sorbistat-K, can extend the keeping quality of beef in tropical and sub-tropical countries for two to three days.

S - 76 E - Oct. 1962 - 1,500

E/CONF.39/D/2
21 Sept.1962
ORIGINAL : ENGLISH

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Agenda Item: D.3.3

United Kingdom

THE FUNCTION OF A NATIONAL PHYSICAL LABORATORY

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THE FUNCTION OF A NATIONAL PHYSICAL LABORATORY

by

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1. Every modern industrial country has found it essential to set up one or more laboratories under government control covering certain areas in the physical sciences which are neither the responsibility of the universities nor of industry. The most obvious area is that of precise measurement in order to provide a sound scientific basis for legal standards of weights and measures. A second responsibility of such laboratories is to provide an independent and impartial authority for the testing of measuring instruments of all kinds used not only by government but also by industry, by universities and research institutions, and even by the general public. The third main responsibility is to encourage and, where necessary, to pioneer the application of advances in pure physics to urgent national technological and industrial problems. This last responsibility is a very wide one and it cannot be sharply defined since industry must carry a large share of this responsibility itself if it is to be progressive and self reliant. Nevertheless there are certain areas and problems which are best tackled by national laboratories under government control, rather than by individual firms or manufacturing industries. This is particularly true when the capital investment is very large in the pioneering stages, or when the government laboratory has special expertise in the new field, or when government must maintain control of the new development for political or other reasons.

2. No two countries have tackled these problems in quite the same way but there are certain features common to nearly all the schemes of organisation. It would be surprising if the under-developed countries found it possible to make industrial progress under a completely different pattern. Thus every country has found it essential to have some form of standards laboratory to fulfil the needs of legal metrology. In general, the ultimate authority for testing instruments is vested in the same laboratory, although the actual testing may be carried out in a number of laboratories situated in various parts of the country. Germany and the USSR have practised such de-centralisation of instrument testing, whereas in Britain the general policy has been to devolve a good deal of the responsibility for testing against secondary standards to industry or to semi-government organisations (e.g. the British Standards Institution or the Research Associations of the Department of Scientific and Industrial Research) leaving the National Physical Laboratory mainly with the responsibility of verifying secondary standards against primary standards.

3. It is in the third responsibility, i.e. of pioneering the application of physics to industry, that the greatest divergences occur. This is not surprising when one considers the magnitude of the problem. Even here there is one feature common to all countries, viz. the establishment of quite

separate laboratories and organisations to deal with the applications of atomic energy for industrial purposes. The magnitude of the effort required in this field is such that it clearly demands a separate organisation, quite apart from its close connexion with defence policy. Although the atomic energy laboratories logically belong to any system of national physical laboratories it has become conventional to confine the use of the term National Physical Laboratory to non-nuclear physics and we shall do so in this paper. There is, however, one important aspect of nuclear physics which is the concern of the national standards laboratories, viz. standards of measurement in the field of high energy ionising radiation and nuclear particles. Since the measurement of radioactive fall-out and the standardisation of radioactive isotopes used in medicine and industry will be one of the first needs of an under-developed country whereas the development of atomic energy will come at a later stage, nuclear physics might well be incorporated with non-nuclear physics in a single national physical laboratory in the initial stages of development.

4. Atomic energy is not the only field where it pays to pioneer the industrial development in government laboratories. Many countries have found it essential to set up government or semi-government laboratories for subjects such as aerodynamics, ship hydrodynamics and metallurgy. In Britain these laboratories form part of the National Physical Laboratory, whereas in Germany, France, Sweden and the United States the corresponding laboratories are not associated with the standards laboratories. On the other hand, radio wave propagation is dealt with in the USA by a branch of the National Bureau of Standards, whereas in Britain what was the Radio Division of the National Physical Laboratory has now become the Radio Research Station, an independent government research laboratory. Such differences are inevitable and arise partly from local conditions and accidents of growth. The fact is that a national physical laboratory must be a complex of laboratories if it is to be useful to industry. In Britain this complex is largely on one site under a single director. In most other countries the standards and testing organisations are separate institutions both physically and administratively. It is for this reason that I shall use the National Physical Laboratory to illustrate many of the points I wish to make about the function of a national physical laboratory with special reference to under-developed areas. Although as industrialisation proceeds, each under-developed country will create the organisation most suited to its needs, it will almost certainly be forced to start with a single laboratory which is likely to have to cover much the same wide ground as the NPL did in the first decades of its existence.

Legal Standards

5. There are two distinct aspects of the standards problem, viz. the legal and the industrial. A legal system of weights and measures is essential for any form of trading whether it be national or international. That system must be based on sound physical principles so that the standards are as nearly immutable as the physicist can make them. Thus the metre is now defined in terms of the wavelength of light - a natural atomic constant. But the Imperial Standard Yard (the legal standard of length in Britain since 1855) is based on the distance between two marks on a metal bar. It has been shown that this distance is contracting by one part in a million every 30 years and this standard will have to be replaced. Until quite recently the yard and the pound as legally defined in Britain, Canada and USA were slightly different. This difference was originally not a serious matter but it was beginning to be awkward in very precise mechanical engineering. It was therefore necessary for the standards laboratories in the countries where the yard/pound system was legal to come to an agreement on an "international" yard and an "international" pound. In order to ensure maximum compatibility with countries using the

metre system, the international yard and the international pound have been defined in terms of the metre and of the kilogram. It is hoped that the international yard will be legalised in Britain in the near future. It has already been legalised in a number of the other countries using the yard/pound system.

6. It might be argued that emergent countries will all adopt the metric system and so avoid the kind of problem just discussed. This is a political question which is outside the scope of this paper but even if a country adopts the metric system, it does not thereby want to trade only with other countries using the metric system. Thus, problems concerned with the compatibility of the two systems will arise no matter which system is chosen and expert advice from a national standards laboratory will be required to resolve them.

7. This raises the question whether the national standards laboratory should have the responsibility for the legal side of metrology. In Britain the legal side of metrology is the concern of the Board of Trade which receives expert scientific advice and guidance from the National Physical Laboratory. In Germany, the Physikalische-Technische Bundesanstalt, and in the USA, the National Bureau of Standards, have responsibility for the legal as well as the scientific side of metrology. What is important is that it should be possible to introduce improvements into the legal definitions of the various units of length, mass, time, power, etc. without involving these quantities in all the relevant trade legislation. It is this unfortunate conjunction which has delayed the legalisation of the international pound in Britain.

8. In addition to the legal side of metrology concerned with trade and commerce, certain legal standards of physical quantities are required to protect the safety and health of the individual. Especially important is protection from radiological hazards in the handling of radioactive materials and X-ray and other equipment in medicine and industry. As a country becomes industrialised one of the unfortunate consequences is the increase in noise, frequently to an almost intolerable level. Yet comparatively few countries have found it feasible to introduce a legal definition of noise based on the readings of some form of noise meter. The difficulty here is that noise is a subjective concept and can only be related to the intensity of a sound wave in a somewhat arbitrary and empirical manner. Just as individuals differ in what they consider to be an unpleasant noise so nations will wish to set their own legal standards for noise. In order to make such standards as impartial as possible their national standards laboratory must have a section devoted to problems in acoustics. The provision of adequate safety factors in the construction of bridges, dams and tall buildings requires expert guidance from aerodynamicists and hydrodynamicists as well as from engineers.

Industrial Standards and Testing

9. The provision of a government laboratory to which industry can refer for the calibration of its secondary standards against the definitive primary national and international standards is so obvious that it is unnecessary to labour this point. Even when an under-developed country has only a small degree of industrialisation, it may find that it is advantageous to be able to check the quality and specification of imported equipment and material in its own laboratories. Moreover, importers may need expert advice in laying down certain of the physical specifications which should be incorporated in the order for the equipment. It might be argued that imported equipment could be guaranteed by the national laboratory of the country from which it is being imported. This is only feasible for a very limited number of exceptionally high quality measuring instruments. It has to be remembered also that any such guarantee applies to the time at which the test was made. Instruments

can deteriorate in certain climatic conditions or can be rendered inaccurate through misuse. To have to refer all such problems to a foreign country would not be a satisfactory state of affairs.

10. Accurate measurement is so basic to all technology that a central laboratory with a group of experts in the science of metrology is vital to technological development in all fields whether industrial, medical or agricultural. New problems of measurement are always arising and many of them are common to quite different branches of technology. It would be a misuse of the limited scientific effort available in most under-developed countries to create expert groups on measurement in the various technologies. Undoubtedly as industrialisation proceeds and the number of trained scientists and technologists increases, some of the larger organisations will develop their own metrological groups but a central authoritative laboratory will always be required by the smaller firms and organisations. The central standards laboratory will of course engage on research in metrology, continually improving methods of measurement and maintaining contact with research in metrology in other countries.

11. The testing of equipment and of instruments may range all the way from being a routine operation which can be carried out by junior technicians to being a research project which demands the attention of a highly qualified scientist. It will usually be advantageous to segregate the routine testing into a separate laboratory but to leave the high grade test work in the standards laboratory. There will tend to be a steady movement of some of the test work from the standards laboratory to the testing laboratory and even to industry. Thus a new problem in measurement is usually referred to the standards laboratory which may develop a prototype instrument. This instrument may go directly into industrial production and use or it may require to be checked by the testing laboratory during an intermediate period. Instruments which are being used in connection with governmental regulations may continue to be tested indefinitely by the testing laboratory.

International Co-operation

12. Any newly established State planning to set up a national weights and measures authority or standards laboratory would be well advised to join the two international weights and measures organisations, the one concerned with scientific, and the other with legal, aspects of metrology.

13. The first, established in 1875 by international treaty (Convention du Mètre) and having a present membership of 38 States, is responsible for fundamental scientific metrology and especially the maintenance and improvement of the metric units and standards of measurement. It operates through the Conférence Générale de Poids et Mesures consisting of delegates from the Member-States, meeting every six years, and an elected executive committee of 18 members, the Comité International des Poids et Mesures, meeting every two years, having the assistance of a number of specialist advisory committees (Comités Consultatives). There is also a central laboratory and office, the Bureau International des Poids et Mesures, situated at the Pavillon de Breteuil, Sèvres, near Paris. The annual subvention for maintenance is provided by subscriptions from the Member-States calculated on the basis of national income in the same way as for United Nations' agencies.

14. The second, established in 1955 by a similar kind of international convention, and having a present membership of 33 States, is known as the Organisation Internationale de Métrologie Légale (International Organisation of Legal Metrology). It has a similar structure to that of the scientific

organisation and is charged with (a) maintenance of a central documentation and information service concerning measuring instruments, the legal requirements relating to them and the departments which test them; (b) the establishment of model regulations in respect of the use and control of measuring instruments; (c) determination of the necessary characteristics and qualities of measuring instruments to enable international use to be recommended. There is no central laboratory; the central office is the Bureau International de Métrologie Légale, 9 Avenue Franco-Russe, Paris VII^{e}. Annual subscriptions from the Member-States are calculated on a population basis, but are quite modest.

15. By joining these organisations a newly established State would immediately have at its disposal the experience of experts in other States in setting up and operating weights and measures authorities and standards laboratories.

More General Responsibilities

16. It was suggested earlier in this paper that in the initial stages of industrial development, a country will have to make its national physical laboratory carry very wide responsibilities in much the same way as the National Physical Laboratory did in Britain during its early years. When the National Physical Laboratory was founded in 1900 it had a staff of about 25 and had two divisions, viz. physics and engineering. It now has a staff of over 1300 organised into the following ten Divisions, viz. Standards, Light, Applied Physics, Basic Physics, Mathematics, Autonomics, Metallurgy, Aerodynamics, Ship Hydrodynamics and Administration (including central services). It should also be mentioned that about ten years ago the Radio and Engineering Divisions were split off to become independent government laboratories (the Radio Research Station and the National Engineering Laboratory) with a combined staff of 835 in separate locations. Moreover, certain of the problems now dealt with by the independent Building Research Station, the Road Research Laboratory and the Hydraulics Research Laboratory were handled by the National Physical Laboratory before these laboratories were set up in 1926, 1933 and 1951 respectively. This brief outline of the past and present responsibilities of the National Physical Laboratory in no way implies that it should be copied by any country making a fresh start on the problem of how best to back its industrial development by one or more government laboratories. Indeed, it is most important to plan carefully and to benefit from the past experience of others, for once the capital expenditure has been made on large laboratories it is a major undertaking to move even part of them to new locations.

17. As a minimum, any new national physical laboratory should cover the classical branches of physics such as heat, optics, acoustics and the more modern branches such as atomic physics, radiology and electronics. It must also cover the mechanical properties of materials and indeed it is difficult to see how it can avoid covering certain parts of mechanical engineering. Similarly it must cover electrotechnics in connexion with the requirements of the system of electric power, whether the latter is run by the state or by private enterprise. In most of these subjects the work will overlap that carried out on standards, e.g. there is no need to have separate laboratories for the standards work on heat and the industrial work on heat when the number of scientists is limited and facilities are also limited as they must be in the early stages of development. Indeed there is much to be said for keeping the standards work and the industrial work together permanently.

18. If a country has any metallurgical industry it would be wise to have a central metallurgical laboratory. It is not essential for this to be part of the national physical laboratory (as it is in Britain) but it would be

advantageous to have it in close proximity to that laboratory. Metals and materials made of metal require to have their fracture, creep, fatigue and ductility investigated in a very scientific manner. Their electrical and magnetic properties (especially when alloyed with other metals or when carefully controlled quantities of known impurities have been added) can be of great economic importance. Methods of extreme purification and standards of purity may have to be investigated. This demands highly sophisticated physical and chemical techniques. This last point raises the question of a national chemical laboratory. In Britain the National Chemical Laboratory adjoins the National Physical Laboratory and each is a great help and convenience to its neighbour. The National Bureau of Standards has a chemical division and no adjoining laboratory. Whether any national chemical laboratory is administratively part of the complex of national physical laboratories or not is unimportant so long as the physicists in the national physical laboratory have close at hand a first rate chemical laboratory.

19. The use of electronic computers in industry is growing very rapidly and automation generally is vital if an industry is to remain competitive while giving its workers a reasonable standard of living. It follows that either within or alongside any national physical laboratory there should be a laboratory for research and some development work on computers and automation. In the National Physical Laboratory this is the responsibility of the Autonomics Division. In addition to carrying out research on methods of improving the speed and efficiency of computers this laboratory is trying to devise machines which will replace human beings in tasks such as the recognition of numerals and letters, translation from one language to another and the retrieval of information. Another of its objectives is to devise equipment which will enable certain industrial processes to be run by self-adaptive control, i.e. when some condition changes and an adjustment has to be made, the equipment will adapt itself to the new circumstances by rapid trial and error of various possible adjustments. Of course such sophisticated research as this last one, will not be done in under-developed countries for several years, but there are many simpler problems of automation which should be studied in almost any industry. Moreover, special purpose small computers require to be devised for particular problems. Imported computers have to be maintained and improved by the addition of ancillary equipment.

20. Equally important is the most efficient use of computers. Computers are expensive in capital cost and in maintenance. It is essential that the programmes for their operation should be devised with as much ingenuity as possible to economise on computer time. This requires trained mathematicians and so it would be wise to associate a group of mathematicians with the centre for research on computers and automation. In the National Physical Laboratory a whole division is devoted to Mathematics but it contains a sizable group of theoretical physicists who can help with the theoretical side of the work done in some of the other divisions. There is no doubt that some mathematicians and theoretical physicists are required in any form of national physical laboratory. Local conditions will usually determine their distribution and organisation.

21. Any country which expects to build its own ships will require to have a towing tank in which to test the hull models and possibly a water tunnel to study certain problems in the design of propellers. These problems are handled by the Ship Division of the National Physical Laboratory in Britain. In other shipbuilding countries this kind of work is done either in conjunction with the corresponding naval work or in semi-commercial establishments. However there is at present so much excess capacity for shipbuilding all over the world that it is unlikely that any under-developed country will find it

an economic proposition to build its own ships for some years to come.

22. On the other hand, there may well be urgent problems in hydraulic engineering which require study by experts, e.g. flood control, harbour and coastal protection. Some of this work was done by the National Physical Laboratory in the early years of its existence. It was found essential to set up a separate Hydraulics Research Station. Although the expert advice required on hydraulics can usually be provided by one of the more advanced countries, some consideration should be given to the provision of a national hydraulics laboratory which might well be sited near the national physical laboratory.

23. Air transport and air defence will certainly loom large in the industrial development of a new country. Consideration should be given to the establishment of a laboratory for aeronautical research. Unfortunately this is a very expensive field of research, since the wind tunnels and associated equipment mean not only a large initial outlay of capital but demand continual modification and modernisation. However, if attention is restricted to the civilian and industrial applications of aerodynamics, as opposed to military requirements, the initial outlay and cost of maintenance might be well worth while in countries where very high winds are a frequent source of danger to civilian property.

24. Although it seldom forms part of a national physical laboratory, some form of meteorological laboratory will be essential in connexion with weather forecasting and weather recording. Although it is still some way from being an exact science, weather forecasting is becoming much more reliable, and the more information that is available the more detailed and accurate is the forecast likely to be.

General Conclusions

25. An under-developed country which is embarking on a programme for the technological development of its resources would benefit enormously from the creation of a national physical laboratory which should be envisaged as developing into a complex of laboratories over a period of about 20 years.

26. This laboratory should initially provide facilities for scientific work in the following fields:-

Standards of mass, length, time, heat, sound, radiation of all types, and of all electrical and magnetic quantities
Electrotechnics
Mechanical properties of metals and non metals
Testing and calibration of measuring instruments
Atomic Physics and Electronics
Meteorological studies.

27. The national physical laboratory should be integrated with the national weights and measures authority and should join the two international organisations for scientific and legal metrology.

28. At the earliest opportunity and depending on the local circumstances and needs, provision should also be made for scientific work in

Metallurgy
Automation and Computers
Hydraulics
Industrial Aerodynamics
Ship Hydrodynamics

29. Some of the work done in such laboratories will overlap partly with that done in industry and at the universities. There is no harm in such an overlap provided care is taken that needless duplication is avoided. It is only by having some overlap that such an institution can have good contact with industry, which it is serving and with the universities, from which it must continually recruit its staff. The easy movement of some staff to and from industry and to and from the universities would be of great benefit to all parties. In the majority of the highly developed countries this movement is all too rare because conditions of employment, pension schemes, etc. have become set into different patterns in these three areas. Although the under-developed countries are starting late in the technological race they can catch up more quickly by learning from the mistakes made in the industrial development of the more advanced countries.

133 E - Oct.1962 - 1,500

E/CONF.39/D/2/Corr.1
29 Nov.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

C O R R I G E N D U M

"Agenda Item D.3.3" to read "Agenda Item J"

133 E - Dec.1962 - 1,600

E/CONF.39/D/2
SUMMARY
21 Sept.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.3.3

United Kingdom

THE FUNCTION OF A NATIONAL PHYSICAL LABORATORY

By Sir GORDON SUTHERLAND, F.R.S.,
Director of the National Physical Laboratory,
Teddington, England

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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THE FUNCTION OF A NATIONAL PHYSICAL LABORATORY

by

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Teddington, England

SUMMARY

A national physical laboratory fulfils the following three principal needs in the technological development of a country:

(a) It provides the scientific backing for the national weights and measures authority responsible for laying down the legal standards of the various physical quantities required in commerce, industry and in the legal enforcement of various government regulations, e.g. hazards to public health and safety.

(b) It provides an independent and impartial authority for the testing, maintenance, verification and improvement of the secondary standards of physical quantities required in commerce, engineering, agriculture and medicine.

(c) It provides a country with a national research centre which can undertake basic and applied work on major problems in the application of physics to industry which cannot be handled by individual firms or organisations but have to be tackled on a national basis.

In connexion with the first two responsibilities, which are to some extent interdependent, it should provide facilities for work in the following fields:-

Standards of mass, length, time, heat, sound, radiation of all types, and of all electrical and magnetic quantities
Electrotechnics
Mechanical properties of metals and non metals
Testing and calibration of measuring instruments
Atomic Physics and Electronics
Meteorological studies.

Nuclear physics has been omitted from this list of topics because it has always been found necessary to have a separate establishment to deal with atomic energy, partly because of the scale of the effort required and partly for political reasons. Nevertheless, it has been found advisable

for the national laboratory to take the responsibility for standards in the field of nuclear energy and radiation. Even when an under-developed country is not going to use nuclear power, it will require radioactive isotopes and will wish to be in a position to measure radioactive fall-out.

For purposes of international trade, it is essential that close co-operation exists on national standards between various countries. This is best done through a national physical laboratory having representation on the two international organisations concerned with the scientific and legal sides of metrology, viz. the Bureau International des Poids et Mesures in Paris and the Organisation Internationale de Métrologie Légale also in Paris. A new country can profit greatly from the experience of other countries by adhering to these organisations and the expense involved is out of all proportion to the benefits which can be gained.

The third responsibility is a very wide one and it cannot be sharply defined since industry must carry a large share of this responsibility itself if it is to be progressive and self reliant. Nevertheless there are certain areas and problems which are best tackled by national laboratories under government control, rather than by individual firms or manufacturing industries. This is particularly true when the capital investment is very large in the pioneering stages, or when the government laboratory has special expertise in the new field, or when government must maintain control of the new development for political or other reasons. It requires not one laboratory but a complex of laboratories which should either be part of, or adjacent to, the national physical laboratory. These laboratories might cover the following areas, the choice and priority depending on the circumstances and needs of the individual countries, viz.

Metallurgy
Electronic Computers and Automation
Hydraulics
Aerodynamics
Ship Hydrodynamics.

The work of these laboratories will overlap to some extent related work going on in industry and in the universities. Unless a country has a national physical laboratory, certain problems vital to the technological progress of a country may never be undertaken either by industry or by the universities. Industry tends to be so pre-occupied with urgent short-term problems that the application of new discoveries in pure physics to industrial processes tends to be neglected. Universities should be left free to pursue the lines of research most suited to the abilities and inclinations of the staff. However, movement of staff in both directions between the national physical laboratory and the universities and industry is important if the maximum benefits are to be obtained.

S - 133 E - Oct.1962 - 1,500

E/CONF.39/D/3
5 Nov.1962
ENGLISH
ORIGINAL : FRENCH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.2.3

Belgium

THE IMPROVEMENT OF SMALL BUSINESSES IN A DEVELOPING COUNTRY

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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THE IMPROVEMENT OF SMALL BUSINESSES IN A DEVELOPING COUNTRY

By
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du Comite National Belge de l'Organisation
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1. The role of the small business in a developing country

In the most highly industrialised countries of the free world, it is notable that small businesses represent more than 90% of the total number of businesses in existence and employ more than 80% of the working population. These two figures are enough to demonstrate their importance in the economic and social life of a country.

Without minimising the influence of the other factors in the development of societies, it can be said that the small business basically plays the role of a "catalyst" of individual energies and activities,

- by stimulating initiative and responsibility;
- by contributing to the spread of techniques;
- by being a factor in increased productivity;
- by creating employment and purchasing power;
- by being a centre for trading in and distributing goods; and
- by promoting the integration of the individual into society by increasing the number of his relationships.

Not only is it an important factor in the social system, but also an essential level in the economic system. It is very closely identified with the trade or occupation. Regardless of the state of development of the area, it offers, where it does not exist, a concept which is easily assimilated. Whether in the primary sector (harvesting, farming and stock-raising), the secondary sector (crafts and small industry) or the tertiary sector (commerce and transport) it is a small unit which is easy to start, highly flexible and capable of expansion.

It is essential, however, that it should be quickly integrated into the overall structure. It is a part of the social

framework which demands careful erection, protection and encouragement, and whose methods of operation must be improved if they are to function effectively.

What direction should it be given in a developing country ?

The economic and social problems which the developing countries have to face differ greatly from one another, especially as regards:

- countries with a western type of civilisation such as Australia, South Africa, South America;
- countries with an ancient civilisation such as India and most Asian countries; or
- countries which have recently gained political independence such as a large number of the countries of tropical Africa.

However, certain common features do emerge in the evolution of these young countries. Under colonial rule the economy of the new countries was actuated by and on behalf of external forces, according to the needs of the foreign country. Now, since political power is restored to the national elite and the needs of the indigenous masses are making themselves felt, it is the Africans and Asians who are going to have to exploit their own countries on their own behalf(1).

This means, as far as agriculture is concerned, that priority, or more precisely the pressure on development over the next few years, will have to pass from export crops (sugar, cotton, cocoa, coffee, bananas, pineapples and oil-yielding crops) to food cultivation and the exploitation of natural resources to supply the population. The small family business will play a particularly valuable role in this task.

In the industrial sphere the import of capital goods and manufactured products essential to growth will give rise to the creation of new industries, each country trying to incorporate the maximum amount of local labour in its imports as well as into its own production. However, since the establishment of new industries is justifiable only if outlets are sufficient, small businesses, with their greater flexibility and economy of operation, will be in the van of industrial development.

The promotion of industrialisation and trade in the less developed areas will therefore depend above all on the development of home markets. Thanks to these local markets the young economies will be able to trade amongst themselves in their food and industrial products, create a local supply to meet local demand and thus achieve the essential balance.

In this phase of development the small business will have an essential part to play.

2. Characteristics of the small business

Attempts have been made to define the small business in terms of size and resources, but it is difficult to agree on a general definition applicable to every type of small business, every activity and every country.

Neither staff employed nor capital invested nor turnover supply a satisfactory yardstick. We must look for other characteristics, and it seems that the general definition set out in the Law establishing the Small Business Administration in the United States might be acceptable:

A small business is one which is independently owned and operated and which is not dominant in its field of operation(2)

The principal factor to emerge from this definition is that the smallbusiness is independently owned. It is autonomous. It is not dependent upon a large company nor is it a body controlled by a public authority. No matter what its constitution or the legal system under which it is allowed to operate may be, it is created and exists by individual initiative.

It is run by the owner himself, who works in it, possibly with the help of sleeping or active partners and perhaps in conjunction with assistants or associates, but who takes all the major decisions himself.

Finally, the small business is not dominant in its field of operation, which means that its resources and methods of action are limited and that its one or several branches of operation are exercised only within certain geographical limits.

Unified management and ownership and a close association between the capital and labour factors - these are the characteristics which enable the small business to perform its allotted task with the power of decision residing in a single person.

It is not necessary for the head of a small business to consult different groups of interests or to reconcile different economic agents. Aims are defined, plans made, data evaluated, factors and means studied and conclusions reached in the head of one man, who knows that he will have to take the consequences of the decisions he makes.

He will therefore try to work flexibly and to see that his private interests are compatible with the interests of his clientele and the general good. He will accordingly be a factor of social and economic coordination, peculiarly advantageous to the building-up of a national structure which must be balanced.

3. Advantages of the small business

By comparison with the large business, the small concern has undeniable advantages:

-- Independence and freedom of decision and action. The head of a small concern, the owner-manager, makes his own decisions as to the aims he can achieve and the policy and methods he intends to use. He takes suitable measures to meet the circumstances, provides for contingencies and follows or abandons an adopted line of behaviour at will, without having to ask the advice or obtain the consent of anyone.

-- Flexibility and speed of adaptation and action. The ability to adapt itself rapidly to changing conditions, and more rapidly than big competitors, is the small firm's trump card.

-- Easy coordination of effort. When plans or circumstances change, the small business can quickly bring its influence to bear on its staff, customers and suppliers. Being limited in number, its internal and external contacts are more direct, more personal and more convincing, thus enabling any adaptation to be made more rapidly and simply.

-- Favourable social climate. The relationship of the head of the firm to his assistants is less anonymous, less administrative, less juridical. More personality, understanding and human warmth can enter into them. The staff, treated as people and not as labour units, bring more goodwill, understanding and responsibility to their work.

-- Individuality of the head of the firm. Having practically no accounts to render, no worries as to the volume of production and only himself to rely on, he is less of a conformist and more receptive to novelty, original ideas and bold experiments, which in certain fields may be the very basis of success. He is more creative and more enterprising.

-- Small investments. The small business can operate with limited fixed assets and working capital. In many fields the fractionated nature and variety of operations and the narrowness of markets make it impossible to use high-output processes, because without large-scale production being fully employed the unit cost of the product would be too high.

-- Lower overheads. Having no high finance charges, nor the expenses of a huge administration comprising more staff, more grades and more auxiliary functions, the small business can undertake certain work at lower cost.

-- Less subject to official interference. Relatively speaking, the small business is subject to less legal obligations than the large. As regards book-keeping, legal, taxation and social welfare requirements, various margins and relaxations are often provided in favour of the small business.

These advantages are of course offset by difficulties of a different order.

4. Disadvantages of the small business

Although in certain respects it may be an advantage for a business to be small, it may also be a drawback.

Although the person running a small business is independent and needs to consult no one but himself, this also means that he has no competent subordinates to keep him informed nor experts to advise him. His technical experience may be excellent but his commercial and financial experience incomplete (or vice versa). Since he has not been able to estimate all its effects in advance, the

decision he takes may be unfortunate or untimely.

No doubt, as soon as a decision proves awkward he can try to put the situation right without delay. But, apart from the fact that certain decisions are irreversible, impulsive and contradictory judgements create disturbances in internal and external relations. Lack of decision at the right time - decisions not taken and left to others for want of precise and methodical information - may also prove disastrous. Hence, ultimately, a tendency to copy what others have carried out successfully.

The small business is very vulnerable to competition. Because it calls for small investments, a limited staff and special knowledge in a restricted field only, the success of a small business often attracts imitators. Moreover, as soon as the market expands, high-output plant may be introduced by larger firms which then want to obtain a larger share of the market for themselves. The small industrial firm is more vulnerable in this respect than the commercial or service firm.

Operating with slender resources and expenditure, the small business generally has no study, documentation or research departments. It is not always aware of progress and takes little part in promoting it. This applies not only to production and equipment but also to organisation and methods. It therefore tends to rely on tradition and established experience and is quickly threatened by newer firms.

Finally, financial resources are often very limited, which severely restricts possibilities as regards plant, stocks, adaptation to markets, sales promotion, loans, expansion, highly qualified staff, etc. It often proves necessary to resort to short-term borrowing, which entails heavier charges than the use of the firm's own capital.

These are sources of difficulty and risk which hamper the development or may even threaten the existence of the small business as soon as economic circumstances turn less favourable.

5. Individual means of improvement

The vital problem of the small business is that of the personality of its owner-manager. Its success does not depend on financial means, clientele, equipment, transport or site, but on the ability and personal experience of the man in charge. For the head of the firm, any steps towards improvement must start from a knowledge of his own strong and weak points and an awareness of his deficiencies.

Being independent and free to make his own decisions, the person running a small business does not always feel that it is necessary to set himself a well-defined plan of action, i.e. a programme. It seems to him that by so doing he is losing part of his freedom of action. What he in fact wants is to retain the ability to reverse his decisions without having to justify himself, even in his own eyes. A programme hampers him, because a comparison with reality reveals inadequate information, a mistaken judgement or absence of continuity of action. This, however, is the very

knowledge on which experience is based; one generally avoids the mistake one has recognised.

Drawing up a programme means deciding on an objective. It also means distinguishing between intangible fundamental principles and adjustments necessitated by circumstances. The person running a small business must learn to make plans, draw up a programme and formulate well-considered, judicious and prompt administrative decisions based on a broad view.

How is this to be achieved ? The means are varied and complementary:

- by seeking the advice of qualified persons (specialists, suppliers, customers, experts, bankers, official bodies etc.;
- by exchanging experiences with other heads of business who have similar difficulties and problems;
- by completing his training on points where it seems inadequate.

One result of deciding on a programme is obviously a certain degree of specialisation. A small industry cannot try to do everything. The local mechanic's workshop very soon starts to specialise, according to the needs of the district, in the assembly and maintenance of agricultural, textile or other machinery. This specialisation in its turn entails the adoption of special tools. Repetition of work leads to greater simplification and the application of more productive methods.

What is true of equipment is equally true of staff management. Repetition work can be entrusted to subordinate labour. The role of the head of the firm then becomes that of an instructor, a leader of men: he delegates his responsibilities. This calls for special aptitudes and appropriate training, because he must learn to direct his assistants.

Step by step, duties must be organised and the work of men and teams studied and coordinated. Outlets for products must be sought, discovered and exploited. The profitability of activities must be observed and checked. It is the application or organisational principles to which the head of the firm must accustom himself.

At the same time as he broadens his view of the future, the head of the business must initiate himself into administration. He must learn to prepare estimates, fix selling prices and draw up forecasts of estimated income and expenditure and long-term budgets covering future requirements and providing for the application of sums which become available. Points such as investment, profitability, depreciation and tax provision must be covered. He will quickly have to develop a good financial brain, which in most cases will have to be acquired.

An intensive effort at personal improvement along these various lines and a multiplication of his contacts with recognised sources of information will thus be the means whereby he makes

good his deficiencies(3).

6. Cooperative methods of action

In addition to efforts at personal improvement, small businesses can avail themselves of another very useful tool, namely cooperation between a number of firms of the same size. Organisation techniques, normally only available to large firms, can thus become accessible to small ones at a moderate cost.

Cooperation is capable of ensuring good results:

- in a given area, by covering different branches;
- in a given branch, by extending it to a wider area;
- in kindred branches also covering a large area.

The first step towards cooperation is the creation of trade associations, whose primary aim is to protect the mutual interests of its members but which soon develop into centres where they can exchange ideas and come to realise that different firms are faced with the same difficulties and problems.

More direct forms of cooperation involving smaller units can then evolve at a later stage, e.g.:

- purchasing groups to secure the advantages of bulk buying (in mechanical engineering the basic materials are often identical);

- collective marketing organisations for advertising, sales promotion, common selling agents, pooled transport etc.;

- joint research units for market surveys, testing laboratories etc.

These are traditional forms of cooperation, but others exist which tend to arise in response to the needs of associated undertakings, e.g.:

- recruiting, personnel selection and training units;

- pooled facilities such as secretarial, legal, accountancy, advertising, patent, insurance and factory health services etc.

Various structures exist for these forms of cooperation, ranging from the full cooperative (more often met with in agriculture than in industry) to the voluntary chain, involving a network of similar firms over a large area, and the small business association, designed to promote closer links without the autonomy of individual firms being lost (4).

Thanks to this form of mutual assistance the trades and industries concerned can automatically benefit from a centralised administration which protects their interests, provides them with the information necessary for the efficient management of their activities and assists them in profitable collective action which would be denied to the small firm on its own.

7. Aid from external sources

The small business is far from being entirely left to itw own devices in its efforts at improvement. Considerable assistance may be available to it from external sources which it might not think of seeking.

(a) Large firms, which sell equipment or materials for processing and at the same time provide substantial technical assistance in the form of advice on the installation and efficient operation of machines and processes. Often occupational training courses are available.

Large firms support small ones, which often represent their best customers. When introducing new articles they offer advice and guidance to small businesses utilising their products, suggest new applications and see that satisfactory results are obtained from them. Examples which quickly spring to mind are the efficient use of constructional material, machinery, electrical equipment, colouring matters and artificial fibres.

Large undertakings also use smaller ones as suppliers or sub-contractors. Du Pont de Nemours in the U.S.A., for example, buys from more than 30,000 firms both large and small(5). It assists them by research, testing, specifications, and technical or organisational advice, which enables them to supply better products at a lower cost to themselves.

As regards credit, installation, sales etc., aid goes far beyond mere advice. Many large firms even finance small ones wishing to set up in business and provide specialists to study their problems(6).

(b) The services of professional bodies are often neglected or under-estimated by small firms. Although the role of the association is to protect and promote the common interests of its members and not to solve the problems of a particular firm, a straightforward explanation of difficulties and drawbacks will often result in useful general advice from the officials of the body concerned, who in turn will be made aware of the current needs of the association's members.

(c) The same remarks apply to economic research institutes, national organisation committees, productivity offices and other study or specialised instruction bodies. A small firm anxious to make headway will do all it can to follow the work of such organisations in improving management methods(7).

(d) Banks and credit institutions should not merely be consulted when finance is needed. Close contact will often lead to useful advice on financial, legal, accounting and taxation matters etc. and will, when the time comes, bear fruit in the form of highly favourable terms between the bank and its customer(8).

(e) Finally, various government and local authority departments in any country are in a position to advise heads of small firms on management problems on which they lack information,

for example economic and social questions, labour legislation and safeguards, statistics, export outlets etc.

In heavily industrialised countries specialised bodies set up by or controlled by the government watch over the development of small firms and provide them with specialised advice (agriculture, crafts and commerce), thus ensuring healthy progress without harmful or stifling interference.

Although all these sources of assistance and information are normally accessible to smallfirms at a low cost, knowledge of them remains all too limited. Chambers of industry and commerce and manufacturers' associations should do all they can to make them known to their members by explaining to them the advantages accruing from such facilities.

8. Conclusions

The following recommendations can be made in closing this necessarily brief account of the means of improvement available to small businesses in a developing country:

(a) Small businesses have a very important part to play in a developing country. Their decentralisation and flexibility of adaptation places them in a better position than big firms to fulfil certain tasks, and their creation, welfare and development should therefore be given every attention.

(b) Although small businesses present certain disadvantages, these can to a large extent be remedied by education and assistance in which large firms, professional bodies and public authorities can all play a useful part.

(c) With the above in mind, small businesses should be encouraged to think in terms of cooperation, which will make them aware of their problems and potentialities. From a government point of view, cooperative institutions are a practical and efficient means of harnessing and coordinating the activities of small businesses in the wider interests of the nation.

The encouragement of a spirit of enterprise, education in economic matters and an awareness of social responsibilities are thus the three broad methods which we recommend in planning the improvement of small businesses.

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128 E - Nov.1962 - 1,600

E/CONF.39/D/3/Corr.1
15 Jan.1963
ENGLISH
ORIGINAL : FRENCH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

C O R R I G E N D U M

Agenda Item D.2.3 should read : D.

128 E - Jan.1963 - 1,600

E/CONF.39/D/3
SUMMARY
15 Nov.1962
ENGLISH
ORIGINAL : FRENCH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D

Belgium

THE IMPROVEMENT OF SMALL BUSINESSES IN A DEVELOPING COUNTRY

By Robert CAUSSIN,
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National Belge de l'Organisation Scientifique,
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THE IMPROVEMENT OF SMALL BUSINESSES IN A DEVELOPING COUNTRY

by

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The small business plays an important part in the building up of a social structure. It contributes to the improvement of production, employment, purchasing power, exchange of information and social relations. It stimulates initiative and the sense of responsability.

It is characterised by the union of management and ownership, by the close association of financial and labour factors, and by the planning decision powers in a single person.

This independence and freedom for the taking of decisions give it flexibility and speed of action that are a highly valuable asset. Besides, it has to a high degree the spirit of enterprise and the important asset of requiring no important investments, or important operational expenditures.

On the other hand, its success is bound with the capacities and with the personal experience of he who manages it. It is very sensitive to competition, is very often managed according to an empirical and traditional method and generally rests on a very narrow financial foundation.

Improvement of the small enterprise in the first place claims for a perfect knowledge of its strong and of its weak points. Establishment of a program recourse to competent advice, exchange of experience with other heads of enterprises, complementary formation of the manager owner must be the foundation of this improvement.

Then come implementation of principles of specialisation, of personel management, of internal organisation, of commercial and financial management.

The action of improvement can be completed by the application of the principle of cooperation, which enables small enterprises to obtain the benefit of organisation techniques that are normally reserved for large enterprises : grouping for purchasing in common for collective marketing, for research and study, etc.

It also can secure the help of large enterprises which are in a position to give considerable technical, commercial and financial aid to the small firm with which they are related either in the role of suppliers or of customers.

The help of professional associations, research, study and teaching organisations can also be very highly valuable. Banks and credit institutions are able, not only to lend direct financial aid but also to supply useful information of problems of management and economic questions.

Finally, the Public Authorities also can give considerable assistance by facilitating the establishment of small enterprises, by ensuring their legal protection and helping their development.

It seems that improvement programs of small businesses, in developing countries, should turn towards encouragement of the spirit of enterprise, economic education and the realisation of social responsabilities.

S - 128 E - Nov. 1962 - 1,600

E/CONF.39/D/4
26 Sept. 1962
ORIGINAL : FRANCAIS

CONFÉRENCE DES NATIONS UNIES
SUR L'APPLICATION DE LA SCIENCE ET DE LA TECHNIQUE
DANS L'INTÉRÊT DES RÉGIONS PEU DÉVELOPPÉES

Point de l'ordre du jour : D.12.2 Sénégal

AVANTAGES DE L'UTILISATION EN RECHERCHE AGRONOMIQUE, DES RADIO-TRACEURS

Par L. JACQUINOT,
Ingénieur-agronome,
I.R.A.T., C.R.A.,
Bambey, Sénégal

Les mémoires rédigés à l'intention de la Conférence des Nations Unies sur l'application de la science et de la technique dans l'intérêt des régions peu développées sont des documents de travail. Ils sont publiés tels qu'ils ont été présentés et les assertions et opinions qu'ils contiennent sont celles de leurs auteurs.

NOTES

1. Les mémoires choisis pour être présentés en séance générale pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

2. Les mémoires choisis pour être présentés en séance spéciale pourront être obtenus à la Conférence dans l'une seulement de ces langues officielles.

3. Les résumés qui ont été rédigés pour tous les mémoires par les auteurs de ceux-ci pourront être obtenus à la Conférence dans les langues officielles suivantes des Nations Unies: anglais, espagnol, français et russe.

4. Préalablement à la Conférence, les mémoires et les résumés ne feront pas l'objet d'une distribution générale mais d'un tirage restreint destiné aux délégations des gouvernements et autres participants officiels. La publication et la distribution générale des actes de la Conférence s'effectueront conformément aux règles et pratiques agréées par le Comité des publications des Nations Unies.

3.053 - D12-2 - AVANTAGES DE L'UTILISATION EN RECHERCHE AGRONOMIQUE DES RADIO-TRACEURS

par L. JACQUINOT
Ingénieur Agronome
I.R.A.T. - C.R.A. BAMBEY (Sénégal)

L'utilisation des radiotraceurs dans les recherches concernant l'agriculture peut-être un moyen rapide et efficace dans les pays en voie de développement où certains problèmes se posent de façon aigue.

On présente ici trois sujets de recherche qui auraient pu être étudiés par les moyens classiques de l'analyse chimique et de l'expérimentation aux champs, mais qui grâce à l'utilisation du ^{32}P et du ^{35}S ont pu trouver des solutions rapides et économiques .

1 - FIXATION DES PHOSPHATES PAR LES SOLS DE CULTURE DE DECRUE DE LA VALLEE DU FLEUVE-SENEGAL

a) Des expériences agronomiques réalisées jusqu'à présent montrent que les phosphates sont sans action sur le rendement des cultures de mils et de sorghos sur les sols de culture de décrue de la Vallée du Fleuve Sénégal .

b) Ces sols, riches en argile (58% pour nos échantillons), sont pourtant très pauvre en phoshore (0,6°/$_{oo}$ de phosphore total, soluble dans l'acide nitrique bouillant).

c) Nous avons mesuré sur des échantillons avec 8 répétitions le phosphore, non isotopiquement diluable, qui correspond à une forme éngergiquement fixée.

d) Chaque échantillon a été saturé de phosphate contenant du ^{32}P en faisant passer sur celui-ci une solution de phosphate bicalcique marqué .

e) La saturation était obtenue lorsque l'activité de la solution éluante égalait l'activité de la solution éluée.

f) L'échantillon était ensuite lessivée par une solution de phosphate sans ^{32}P et chaque portion de 10ml était mesurée au compteur.

g) Nous avons pu ainsi évaluer la quantité de phosphore isotopiquement diluable dans chaque portion et trace une courbe représentant le phosphore isotopiquement diluable.

h) En comparaison le même travail fut effectué avec un sol Dior sableux de la Station de Bambey.

i) On trouve ainsi que le sol de la vallée du fleuve retient après saturation 92% du phosphate, sous forme non isotopiquement diluable contre 28% pour un sol Dior.

j) Soit une fixation énergique de 195kg/ha contre 45kg/ha.

k) D'autre part on observe encore 48 heures après l'expérience une nouvelle fixation de phosphate par le sol apres saturation.

l) Tous ces résultats expliquent alors le manque d'efficacité des engrais phosphatés dans ces sols et donnent un ordre de grandeur de la fixation des phosphates.

m) Cette étude a donné environ 8 jours de travail complet.

n) Elle a demandé 500 comptages de radioactivité, la confection de 10 litres de solution à 20mg par litre de phosphate bicalcique dont 10 litres additionnés de 1 mC de $^{32}P\ O4\ H_3$.

o) Le procédé classique aurait demandé 1 mois à temps complet pour le dosage de ces échantillons, mettant en oeuvre de nombreux réactifs, une verrerie considérable et l'immobilisation du laboratoire pendant tout ce temps.

Bibliographie : (1) (2) (3) (4) (5) (6).

2 - DISPERSION ANEMOPHILE DU POLLEN DU MIL

Le mil étant allogame il est intéressant pour le généticien de mesurer à une distance déterminée le taux d'allogamie de cette plante :

a) méthode classique : au centre d'un champ de plantes présentant pour un caractère qualitatif simple à observer, le phénomène récessif, on sème une ou plusieurs plantes présentant le phénomène dominant.

i) Les graines récoltées sont semées et les descendances observées. On note la proportion de phénotypes dominant qui correspond au taux d'allogamie à une distance donnée.

b) méthode au ^{32}P : on plonge une racine de mil en place, dans une solution de $^{32}PO4\ HK_2$ avec entraîneur contenant 2 mC de ^{32}P huit jours avant la floraison.

i) A la floraison le pollen est fortement radioactif (20 grains de pollen donnaient 50 coups par seconde).

ii) Ce pollen est recueilli sur des bandes de papier adhésif en cellulose que l'on calcine et dont on passe les cendres au compteur.

iii) Les premiers essais permettent de détecter le pollen très facilement jusqu'à 10m du pied contaminé.

iv) Les résultats furent connus 15 jours après la floraison. Cette expérience a demandé pour être réalisée :

- 1 tube à essai contenant un peu de phosphate et 2 mC de ^{32}P.
- quelques bandes de papiers adhésifs.
- une cinquantaine de comptage.

La méthode classique demandait au moins :

- 1/2 ha de culture
- des plantes ayant un caractère récessif soit dominant
- de nombreuses observations en deuxième année
- 1 an au moins de délai avant de connaître les résultats.

Bibliographie : (7) (8) (9) .

3 - ETUDE AU MOYEN DE ^{35}S DE LA REMANANCE D'UN INSECTICIDE SUR LE MIL.

a) Un fabricant annonçait que l'un de ses produits, le O,O, diethyl, S (éthylthiomethyl) phosphorodithiotate était susceptible de protéger les graines contre les prédateurs et même la jeune plante après germination.

b) Des graines de mil furent traitées avec ce produit marqué au ^{35}S puis semées dans cinq vases de végétation. Les jeunes feuilles furent prélevées à 15, 20 et 25 jours de végétation.

c) On effectua ensuite des chromatographies sur l'extrait acétonique de ces feuilles et sur le produit avant traitements.

d) Les chromatogrammes furent analysés ensuite au compteur Geiger.

e) Cette analyse nous montra que le produit était hydrolysé en totalité dans la plante et même en grande partie dans le sol.

f) Il n'a donc d'utilité que pour protéger les graines pendant le stockage.

g) L'expérience a duré environ un mois.

h) Une étude classique aurait demandé au moins trois années de répétition sur 2 ha, l'un traité l'autre non, sans que l'on soit certain d'obtenir un résultat probant.

Bibliographie : (10) .

4 - C O N C L U S I O N

a) A l'aide de ces trois exemples réalisés au Sénégal nous voyons que l'utilisation de radiotraceurs dans certaines études permet de réduire de façon considérable la durée de l'expérience en même temps qu'elle la simplifie. A ces deux facteurs important s'ajoute la diminution.

b) L'intérêt de l'utilisation des radioisotopes en agriculture n'est plus à démontrer.

c) Notre propos était simplement de montrer quels services ils avaient pu rendre au cours d'une année d'expérience.

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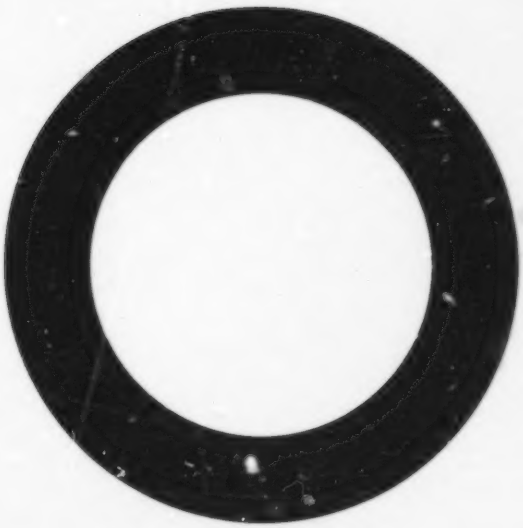

E/CONF.39/D/4
SUMMARY
15 Oct.1962
ENGLISH
ORIGINAL : FRENCH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.12.2

Senegal

ADVANTAGES OF RADIOACTIVE TRACERS IN AGRONOMIC RESEARCH

By L. JACQUINOT,
Agronomist,
I.R.A.T. - C.R.A. Bambey,
Senegal

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

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ADVANTAGES OF RADIOACTIVE TRACERS IN AGRONOMIC RESEARCH

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I.R.A.T. - C.R.A. BAMBEY,
SENEGAL

Based on a number of experiments at the Bambey Agronomic Station in Senegal.

(a) Study of the fixing of phosphates in soils exposed after flooding along the Senegal River, by using P^{32} to measure phosphorus in a form not subject to isotopic dilution.

(b) Study of the wind dispersal of millet pollen, by marking with P^{32}.

(c) Study, by means of S^{35}, of the value of a recent insecticide as a systemic retained in millet seed.

2. This method which saves time and simplifies experimental procedure, is shown to be particularly suitable for agronomic research in developing countries.

S 140 E - Oct.1962 - 1,600